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Powered two-wheelers road accidents and their risk perception in dense urban areas: Case of Paris

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ABSTRACT

For a few years, the use of powered two-wheelers has taken off in Paris. It then became critical for the City of Paris to understand both the mechanisms leading to traffic accidents involving at least one powered two-wheelers user and the perception of their risk when riding in dense urban areas. In so doing, two studies were carried out along similar lines so that their results could be compared. The first study focused on the perception of situations where accidents are most likely to occur. The second one was an analysis of police reports of accidents involving at least one powered two-wheelers and the drawing-up of prototypical accident scenarios. Comparing the results of the two studies revealed a gap between perceived and objective risks of these users. In fact, they rather fear the situations during which a car driver is changing lanes, while accidents involving them occur more often when a car driver turns (right, left or U). Knowledge of this dissonance in terms of awareness of road risks for powered two-wheelers and equally, other road users, will give the City of Paris food for thought. The promising results of this study have encouraged the City of Paris to extend it to other types of users, such as cyclists or elderly pedestrians.

1. Introduction

1.1. Definitions and scope

The term "powered two-wheelers" (PTW) is used to refer to mopeds, scooters, and motorcycles; and commonly includes similar three-wheeled vehicles.

In France, the definition of the severity of an accident changed in 2005. Before that, a road accident victim was considered as "slightly injured" if the person was hospitalised for less than 6 days; "seriously injured" if the person was hospitalised for at least 6 days, and "killed" if the person died within 6 days after the collision. Since January 1st 2005, a victim is considered as "slightly injured" if the person is not hospitalised or hospitalised for less than 24 h; "seriously injured" if the person is hospitalised for at least 24 h, and "killed" if the person died within 30 days after the collision.

The Parisian territory includes different types of roads, with various speed limits: on the ring road the speed limit is 80 km/h, on the thoroughfares and urban roads the speed limit is 50 km/h, and in residential streets the speed limit is 30 km/h. In this paper, we focused on road accidents that happened in Parisian urban areas. Thus we excluded all the accidents that happened on the ring road and its slip roads, as they are not considered as urban areas.

1.2. PTW road accidents

Nowadays the safety of PTW riders is a growing crucial issue, not only where public opinion is concerned, but also on account of their very number, particularly within urban areas. Moreover, motorcyclists and moped riders constitute, along with pedestrians, one of the most vulnerable groups of road users, in urban areas. In his report entitled "Gisements de Sécurité Routière. Les Deux-Roues Motorisés", the prefect Guyot (2008) explains that problems relative to safety and PTW riders are ongoing issues at a national level. In France, those riders represent about 1.5% of all traffic within the road network (Guyot, 2008). But in built-up urban areas this share of overall transport means is much higher. The use of PTW has risen sharply in large French towns, especially in Paris and its outskirts. Indeed, since 1997, the City of Paris has seen the number of riders traveling on its road network literally explode. The use of this means of transport has risen by 64.0% (Mairie de Paris, 2010). The traffic of PTW for 2009 in Paris stands at 8% on the Parisian ring road (Mairie de Paris, 2010), and at 17% within Paris (Mairie de Paris, 2010). Although the increase in the percentage of accidents involving at least one PTW rider (taken against the total number of Parisian road accidents) is not proportionate to the increase in PTW traffic as a whole, they are more and more implicated.

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Table 1
Types of road users involved in 2009s Parisian road accidents.

	Accident involving at least one		Number of users or vehicles involved	
Pedestrian	1900	26.6%	2029	15.1%
Cyclist	701	9.8%	720	5.3%
Powered two-wheelers	4478	62.7%	4691	34.9%
Car or commercial vehicle	4892	68.5%	5630	41.8%
Other	380	5.3%	384	2.9%
Total	7142		13,454	100.0%

In 2009, within Paris (ring road and slip roads excluded), the Parisian police forces identified that PTW were involved in 62.7% of the traffic accidents (4478/7142), against 52.1% in 2000 (4736/9096). This represents an increase of about 20%. Power two-wheelers represent 41.0% of the vehicles involved in a road accident in Paris (Table 1). 19.4% of them were involved in single-vehicle crashes.

It is noteworthy that since 2000 the number of accidents (all users taken together) decreased by 21.5% in Paris (9096 versus 7142), whereas those that involved at least one PTW rider, decreased only by 5.4% (4478 in 2009 versus 4736 in 2000) (Fig. 1). Along similar lines, the percentage of PTW riders among the seriously and fatally injured has increased by 19.5% since 2000 (43.5% in 2000 to 52.0% in 2009). Indeed, in 2009, 361 PTW riders were killed or seriously injured (hospitalized) on Parisian urban roads (Fig. 2). Compared to this, a drop of 18.7% of the number of pedestrians killed or seriously injured (40.9% in 2000 to 33.3% in 2009) was noticed and as well as drop of 34.5% for drivers of cars and commercial vehicles (12.3% in 2000 to 8.1% in 2009).

The recent increase in the use of PTW in urban areas, the over-involvement of this category of road-user in road-accidents and their over-representation among victims, demonstrates the need of a better understanding of the mechanisms of accidents involving them, and of their perception of accident risk in urban areas, in order to develop appropriate prevention policies.

1.3. The concept of risk in road safety

In ergonomic terms, an accident is seen as resulting from a fault in the system. Given a road is a systemic whole, the difference between perceived risk and real risk can be seen as an aggravating factor in accident-occurrence.

Where road risks are concerned, numerous model-types attempt to make connections between objective (real) risk, measured from solid data, characterizing any given situations or essentially cognitive ones, and the subjective (perceived) risk, which corresponds to how an individual weighs the situation up, and the operation which precedes choice of behavior (Saad, 1998). All these models put forward ways of lessening the sometimes large gap between "objective" and "subjective" risks. Besides this, these models include certain of the user's tendencies toward the risk. Two ways of viewing motivations result in the use of one or other group of models, both arising from the decision theory. One supposes that every individual is looking for a perceived risk level that is close to zero. Three models result from this postulate. The zero-risk model can be applied to a risk of either an accident or a penalty (Näätänen and Summala, 1976). This perception would be close to zero and when it exceeds a certain threshold, regulatory mechanisms would intervene. As the alert threshold is generally too high for users, the gap between a non-zero objective risk and its zero subjective assessment could explain accidents. Thus there would be a need for intervention, in order that no gap exists between the objective and the subjective estimates. Regarding the model for avoidance of threat (Fuller, 1984), it is both critical and a complement to the latter, it extends its approach to the wider context of potential environmental dangers. Finally, the hierarchical risk model for traffic (Van Der Mollen and Botticher, 1986) exposes the problem of planning the activity and emphasizes the role of demonstrations in the planning.

Wilde (1988) drew up one of the most thorough models for road safety: the risk homeostasis theory. This theory presumes that the choice of goal-related behavior in a situation of risk is subject to the confrontation of two representations: the preferential risk on the one hand, and the perceived risk on the other hand (Fig. 3). The preferential risk is defined as a subjective level of risk, wherein the subject considers that the relationship between expected benefits and anticipated costs of adopting a behavior, such as it can be envisaged, is at its greater. Expected risk is equally mentioned, or an optimal level of subjective risk. The level of preferential risk is determined by four types of subjective utilities: (1) benefits expected to result from risky behavior, (2) costs expected to result from such behavior, (3) benefits expected to result from adopting a safer behavior, (4) the expected costs of adopting these different types of behavior. So the risk is a dissonance factor, resulting in higher levels of subject reaction (Berlyne, 1970; Mace, 1979). To a certain degree, this dissonance can have positive effects: certain users who fear a certain kind of accident will pay more attention to it, and will know how to prevent it.

If preferential risk consists of anticipating the costs and benefits of future behavior, perceived risk is otherwise constituted, and has its reference point in assessment of real dangers. A sense of risk is dependent on the subjective probability of an accident to occur, and its subjective valence (severity). Both factors do not systematically contribute to the elaboration of perceived risk. Some research findings (Howarth, 1988; Robaye et al., 1963; Blomart, 1963) suggest that perceived risk, as a decisive variable in behavioral choice, would arise rather from the severity of failure within new situations, and its likelihood of such failure occurring in familiar situations (Delignières, 1991).

In this study, we will consider as "perceived risk" the situations feared by the user, those he considers as potential causes of accidents; and as "objective risk", the real accident analysis within Paris. The assumption is based on the idea that an accident occurs when a too large gap exists between these two concepts.

1.4. The study of accident mechanisms

Several studies have examined the concept of prototypical accident scenarios. Fleury and Brénac (2001) explained that a prototypical scenario of an accident can be defined as "a prototype of an accident process corresponding to a series of accidents which present overall similarities regarding the chain of facts and causal relationships throughout the various accident stages". But not all of these studies lead us to the same results and do not necessarily target PTW riders. Clabaux (2007) identified three major categories of accident scenarios: those related to the phenomena of obstructed visibility, to the phenomena of low conspicuity of the PTW, and those corresponding to accidents generally involving a PTW rider overtaking a vehicle or a queue of vehicles. Hurt et al. (1981) showed that PTW are over-represented, compared to cars, in accidents occurring on roads with bends or those involving failure to give way to the right. They also noted that in the case of non-single-vehicle crashes collisions, the driver of another vehicle is considered responsible in 60% of cases, usually due to a failure to give way to the right. Sexton et al. (2004) reported that motorists commit errors when turning left or U-turning just in front of PTW. As for Sporner and Kramlich (2000), they identified five prototypical scenarios: a vehicle turns or crosses a lane while the PTW is in a priority lane (46%); a car turns left and hits a PTW coming from the opposite direction (26%); a PTW overtakes at the same point